**Abstract-** NASA in collaboration with the Department of Energy (DoE) has invested and committed to utilizing a Nuclear Fission-based Surface Power System (FSPS) to power future lunar operations. This paper presents a framework for sequential decision-making methodology to analyze the expected levelized cost of electricity (LCOE) generation of FSPS in the presence of energy demand uncertainties.

The conceptual design of the implementation of FSPS conducts a comparative analysis of flexible and robust strategies, conducting a demonstration that aligns with a widely established by NASA’s previous operations and planned Artemis program, over a projected 20 year timeline. A preliminary study based on default parameters (from previous literature) suggest that a flexible approach can decrease the expected cost to \_\_\_USD, \_\_% less compared to an inflexible development with an average expected cost of \_\_\_USD.

This paper proposes an intuitive engineering system design approach in the novel and cost intensive context of lunar energy supply, shedding light to the benefits of embedded flexibility in the implementation of power on the moon. This model will equip stakeholders with a simple tool to adapt as technologies and parameters evolve, offering strategic insights to minimize costs and navigate uncertainties associated with energy on the Moon. This methodology improves existing approaches for decision-making, and this scenario can potentially provide guidance for other extreme environment with high uncertainties, costs, and limited access to resources.